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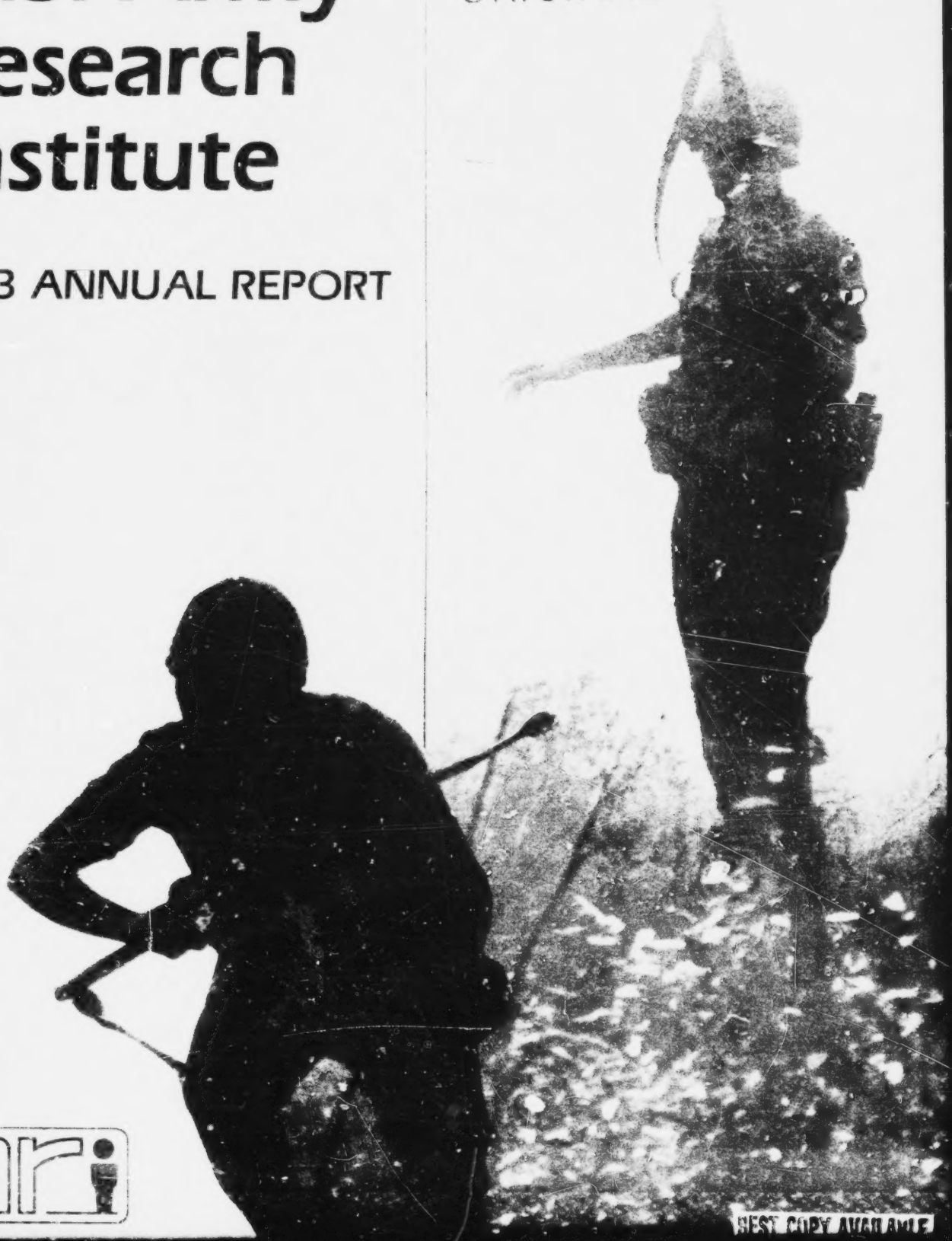

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U.S. ARMY RESEARCH INSTITUTE

for the BEHAVIORAL and SOCIAL SCIENCES

Col. L. Neale Cosby, *Commander*
Dr. Edgar M. Johnson, *Technical Director*

1983 ANNUAL REPORT

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The U.S. Army Research Institute
for the Behavioral and Social Sciences
5001 Eisenhower Avenue
Alexandria, Virginia 22333

NOTICE

NOTE: The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

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Message from the Commander

Colonel L. Neale Cosby, Commander, ARI

The Army Research Institute (ARI) is a field operating agency of the Deputy Chief of Staff for Personnel employing approximately 300 people with an annual budget (FY83) of $36 million. Our job centers on soldiers and research. We conduct research in the acquisition, development, training, and utilization of soldiers in military systems. Traditionally, the Army approaches this job more from the standpoint of manning the equipment than of equipping the man. Our aim is to see that the emphasis is upon the latter—that the capabilities of the soldier are built totally into the systems acquisition equation. Only then will our weapons systems approach their full effectiveness.

At ARI we are developing better tools for selecting and classifying soldiers as well as better techniques for training and leading them. Our ultimate success will be measured in greater unit effectiveness at the battalion level. I believe our Annual Report for FY83 reflects the kinds of research products—ranging from STINGER reverse engineering to a hand-held vocabulary tutor—that will contribute to this goal. Our big project in selection and classification got off the ground this year, and we should begin to reap the benefits soon. For example, this effort will enable the Army to select and place, as M-1 tank commanders, only those persons with predictably high levels of performance. As a result, the combat effectiveness of a tank company, as measured in enemy hits, could increase two to three fold.

While these research projects will make significant contributions to the Army, they only scratch the surface. Much work remains for us in such areas as force integration, leadership at the junior and senior level and embedded training. We must help the Army make better use of the data bank at the National Training Center (NTC). We have made a start on work in the area of artificial intelligence—using machines to make the soldier's work easier. I strongly believe that artificial intelligence and the so-called "smart systems" offer one of the most fertile grounds for the future of soldier research, and that we must rapidly advance our efforts both fiscally and programmatically if we are to capitalize on its full potential.

This annual report provides only a glimpse of our work at ARI and how we go about it. Our work is important only if the users in the field are able to properly integrate the results into Army doctrine, procedures, and policies to make positive and lasting changes in the Army. In order to do that, we need a strong user-research relationship. We at ARI are making a concerted effort to strengthen those ties and invite your comments on better ways of doing that. We welcome your queries into the details of the activities highlighted on the following pages or into the many others making up our full research program.

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Message from the Technical Director

The Army Research Institute is an applied research organization committed to excellence. ARI is end-product oriented, bringing scientific knowledge to bear on solving real and important challenges facing the Army. Our focus is and will remain on technical excellence to enable the Army to successfully meet the challenges of the future. Excellence has a dual focus upon products and science. This annual report demonstrates our commitment and the recognition of this commitment in several dimensions:

- *products—ranging from a manual for intelligence analysis and design of an artillery battery crew, to development of an officer evaluation test battery;*
- *scientific contributions—some 30 journal articles, books and book chapters published and more than 60 papers read at professional meetings; and*
- *professionalism—the Army R&D Achievement Award for the Recruiter Development Center and a $5,000 incentive award for research on the Target Acquisition and Analysis Training System.*

Dr. Edgar M. Johnson, Technical Director, ARI

Applied research does not just happen; people make it happen. Solutions to Army problems occur when the knowledge and understanding of an Army need, and the technical and scientific knowledge and insights to cope with that need, come together in the heads of people who make things happen. Our incentive awards program has been focused on researchers, providing nearly 100 awards to outstanding researchers and support staff. New senior leadership is in place at ARI, providing an exceptional management team. During FY83, we selected a new Director of the Systems Research Laboratory and new leaders in 7 of our 15 Technical Areas and Field Units.

We have moved to strengthen our ties with the university community. In addition to a continuing use of graduate students as research assistants, we have enlisted faculty members as consultants and part-time researchers and have established a Research Associateship Program through the National Research Council. We have also moved to strengthen our ties with industry through collaborative efforts and through supporting activities of the National Security Industrial Association.

There have been a number of initiatives during the past year to improve our productivity and the quality of our research. An external peer review system has been established using nationally recognized experts to review selected research efforts. A Research and Development Advisory Group

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has been established through the Army Science Board to provide advice and counsel on program direction and quality. We have embarked on a laboratory modernization program bringing our computing, research and information systems up to date. We have opened Research Coordination Offices at PM TRADE and at TRADOC Headquarters to strengthen ties with our users. Last, and most important, we have completed a first long-range plan to chart the research future for ARI.

This report presents an overview of our activities during the last year: breadth of mission, variety of publications and research accomplishments, strength of technological change, and impact on policy and operations. We have moved from a focus on individual attributes to a focus upon the "whole man" with his hardware in a unit context—a total systems approach.

ARI's challenge is to provide the research products required to meet the needs of an Army of Excellence. The annual report for FY83 reflects our response to that challenge. The future offers new research opportunities in such areas as artificial intelligence, training strategies, soldier-system integration, and low-cost simulation and training devices. ARI's mission is to make the future happen sooner: to ensure that the "whole man" is considered in a systems context. This supports ARI's and the Army's commitment to excellence.

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FY83 Program Management

The Army Research Institute

The Army Research Institute for the Behavioral and Social Sciences, informally known as ARI, is a field operating agency of the Deputy Chief of Staff for Personnel. It includes civilian scientists, military personnel, and appropriate administrative and support personnel. Complementing the headquarters and research center in Alexandria, Virginia, are 13 field units and scientific coordination offices.

ARI Locations

Mission

The Army Research Institute conducts basic, exploratory and advanced research toward increased readiness and effectiveness of Army personnel. ARI's assigned mission is to maximize combat effectiveness through research on the acquisition, development, training and utilization of soldiers in military systems. Applying state-of-the-art concepts and methods of the social and behavioral sciences, ARI's staff, including some 226 professionals, helps to solve current Army problems and to make future problems more manageable.

ARI research helps the Army recruit and retain the best people by developing a scientific understanding of soldiers and the tasks they perform. This understanding is applied to maximize individual and organizational effectiveness in light of modern battlefield tactics that rely on increasingly advanced equipment and technological systems. ARI conducts people-related research and concentrates on the design of peacetime training systems and manpower programs that can maintain an Army equal to the challenges of war.

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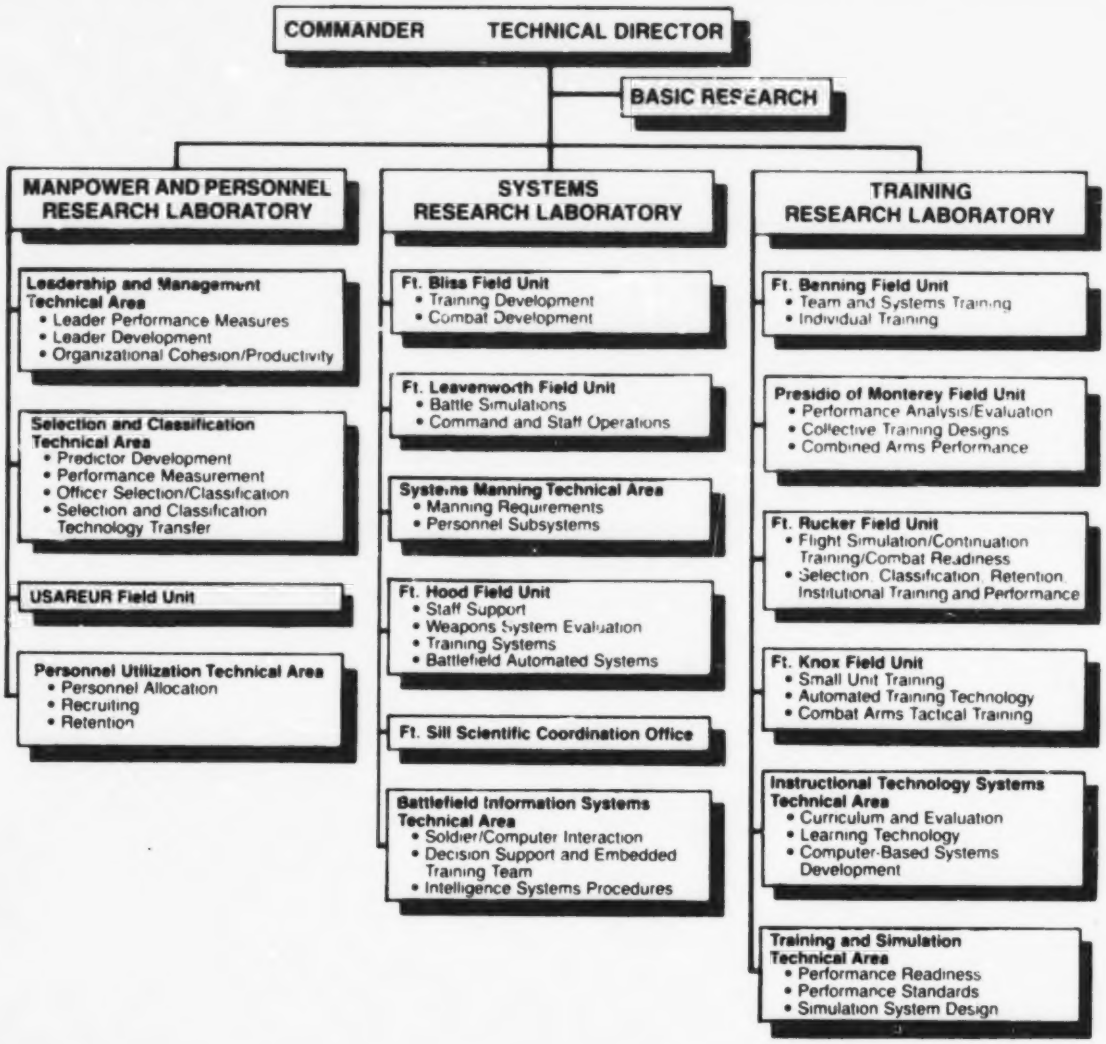
Core Program

ARI's core program falls into three general areas: Manpower and Personnel Research, Systems Research, and Training Research. Three specialized laboratories execute the research. Field Units fit into ARI's three-laboratory structure with current efforts aligned so that specific research thrusts are pursued by the field unit or technical area with the best available resources.

Organizational Structure of the Army Research Institute



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Manpower and Personnel Research Laboratory

This laboratory focuses upon designing and developing methods to improve the process of recruiting, selecting, assigning and retaining Army personnel. Related efforts seek to improve the effectiveness of military organizations, particularly through analysis of Army organizational structure, management and leadership, and the dynamics of unit cohesion.

Dr. Joyce Shields, Director, Manpower and Personnel Research Laboratory

The Manpower and Personnel Research Laboratory uses knowledge and techniques of the behavioral sciences to address the difficult challenge of developing tools and procedures to aid decision makers in the Army's personnel system. The Officer Selection Battery and the Military Applicant Profile are two of this laboratory's more recent successes.

In the year ahead we expect to see the initial results of an ambitious new program to develop selection and classification procedures for optimizing the match between soldier abilities and MOS requirements. As part of this research effort we are finding new ways of measuring and collecting data on the military applicant pool, and developing and evaluating new predictors and measures of soldier performance, including psychomotor and perceptual skills, cognitive abilities and biographical information.

Other research programs focus on the personnel requirements for manning the Air/Land Battlefield of the Year 2000. Personnel resources for meeting those requirements will be identified and methods to recruit, select, classify, and assign personnel to training tracks in such a way as to optimize the fit between Army skill requirements and individual capabilities will be developed. The program will focus primarily on the active force with an eye to applications in the reserves and civilian forces.

Systems Research Laboratory

The Systems Research Laboratory conducts research on how to realize optimum performance from Army personnel who operate or interface with the new systems entering the Army inventory. Modern psychological concepts of human perception and cognition are applied to the design of systems and the procedures for their use. Human performance capabilities and limitations are brought to bear on the Army's efforts to develop and field equipment which people can effectively operate and maintain.

Dr. Jerrold M. Levine, Director, Systems Research Laboratory

As the wave of high technology sweeps over the Army, the job of the Systems Research Laboratory increasingly has to do with ensuring that this technology enhances total system effectiveness. Through our research we continue to identify and demonstrate ways of helping the soldier do his or her job better. These include computerized aids to decision making to help commanders on the battle field sift through the overwhelming body of tactical information now at their finger tips.

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Our current research efforts are expected to result in several dramatic changes for the Army in the coming year. A simulation system for defense weapons will become operational and permit research directed at improving [illegible] performance and total system effectiveness. Changes in the consideration of human factors, manpower, personnel and training during system acquisition are expected to be implemented as a result of our "reverse engineering" studies. A continuation of our research in command and control will help identify those behaviors critical to successful command as well as weaknesses which can be improved through training.

Several of our research efforts are intended to result in payoffs a few years from now. Research soon to begin in adaptive battlefield automated systems will design a soldier machine interface to help manage information flow and intelligence for small unit commanders in an adaptive, user-friendly fashion. Additional efforts are being devoted to advanced methods for presenting information in graphic format and to the use of speech as a computer input modality. Those activities are designed to enhance soldier and unit effectiveness through the development of new and improved information processing systems.

Training Research Laboratory

The Training Research Laboratory, drawing on existing theories of learning, motivation, cognition, measurement and evaluation, continuously examines and refines, through research and development, the training methodology and practices employed by the Army. Current research seeks to identify the specific skills required for successful performance in the Army and ways to improve the basic skills of marginal performers in order to increase their chances for successful Army careers. Training research is also developing more cost effective training methods through simulation and training devices.

The Army's growing accent on training is paying off in a force that may be better prepared for its mission than ever before. Despite this, extremely tough challenges remain to be solved through continuing research. In the reserve component, where we have less than 37 days a year to train, it is hard to maintain the increasingly complex skills required by the Army's modern systems. Through intensified research in the year ahead we will be developing rapid train-up procedures to achieve and maintain higher levels of readiness in the reserves. We will continue to address the Army's need for improved training of maintenance personnel, placing special focus on the M1 tank.

Within the Training Research Laboratory, efforts are now underway that should lead to a whole new family of low cost training devices and simulators which can provide training at previously unmatched levels of efficiency and effectiveness. In the year ahead we will be intensifying our research on applications of technology to the instructional needs of every soldier. A specific focus in this regard will be upon computer-based instruction and other promising new developments in the field of instructional technology.

Basic Research Program

The Basic Research Program within ARI is intended to fill gaps in the scientific methodology and data base. This program is implemented primarily through contractual efforts with the academic community, resulting from peer reviewed unsolicited proposals. At the present time there are some 60 such contracts with different universities or organizations in the United States. In addition, a small number of efforts are supported within the European and Middle Eastern research communities. This program follows the same programmatic lines as the three major ARI laboratories.

The Basic Research Office serves as the leading edge of ARI's research program. It is our job to identify the concepts and explore the technologies which offer the greatest potential for transition to

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applied research on the problems facing the Army as it prepares for the Air Land Battlefield of the Year 2000 and beyond. Military forecasters predict widely dispersed battlefield systems and soldiers,

Dr. Robert Sasmor, Director—Office of Basic Research

time compression, and sophisticated equipment requiring vastly more complex tasks of the soldier than today. Without adequate preparations, we can expect a critical man-machine mismatch, an extensive information overload, and an increasing shortfall of soldiers capable of performing the complex tasks that will be required of them.

Basic research is underway in areas where the payoff to the Army appears highest. Included among these are informational engineering, artificial intelligence, ability assessment, instructional techniques and systems, and cognitive processing capabilities. These efforts will emphasize the use of computers, capitalizing on their high-speed potential and matching them as closely as possible to the capabilities and requirements of their human operators. As our basic research program builds the scientific knowledge and technical data base in these new and emerging areas, ARI will be able to focus its applied research on advancing the products so vital to the Army's future mission.

Program Resources

The interdisciplinary research and development team at the Army Research Institute consists of 251 scientists and military professionals, assisted by 143 administrative and technical support personnel. ARI's program resources in FY83 totaled 36.5 million dollars and were apportioned as shown.

The next section of this report provides an overview of ARI's research program together with representative examples of ongoing research efforts.

Annual Expenditures ($1000)

	FY81	FY82	FY83
6.1 Basic Research	2,170	2,779	3,165
6.2 Exploratory Development	9,014	9,524	9,619
6.3 Advanced Development	15,632	18,483	23,744
Total	26,816	30,786	36,528

ARI Personnel by Category — FY83

Professionals by Scientific Discipline	
Experimental Psychologist	46
Human Factors Psychologist	47
Training Psychologist	39
Industrial Organizational Psychologist	19
Personnel Psychologist	25
Quantitative/Math/Statistician	9
Computer Science Specialist	7
Social Psychologist	4
Operations Researcher	6
Educational Psychologist	7
Economist	4
Sociologist	1
Engineer	2
Other	10
Subtotal	226
Military	28
Administrative and Technical Support	143
Total	397

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FY83 Research Program: An Overview

Program Planning and Coordination

ARI receives broad guidelines for its research program from Congress and the Department of Defense, but its principal clients are within the Army. Because ARI products affect every Army mission having human performance as a component, Army leadership participates in the specifics of program development at ARI. Regularly scheduled reviews and evaluation of the Institute's research program are chaired by the Assistant Deputy Chief of Staff for Personnel. Vital input comes from the Army staff, major Army commands, the Secretary of the Army, and the Chief of Staff. Senior user reviews generate input to major programs. The results of Mission Area Analyses are also used to ensure that ARI's research program encompasses problem areas of high priority to the Army. Each review is instrumental in providing invaluable feedback from principal users to the ARI program managers as well as assuring that the Army's leadership is cognizant of the activities in each program area discussed.

In support of program planning, ARI coordinates research at several levels. Within the Army, ARI maintains scientific coordination offices (SCO) at FORSCOM and TRADOC. The FORSCOM SCO represents ARI and serves as the senior scientific consul for personnel and training research at the US Army Forces Command. It also coordinates FORSCOM research requirements with the Command Group and research elements as well as troop support requirements. The SCO at TRADOC performs similar functions at the US Army Training and Doctrine Command. In FY83 a new SCO was established at PM TRADE in Orlando, Florida, to expand coordination of research in the development of simulators and training devices. Tri-service cooperation exists among ARI and its other service counterparts: the Navy Personnel Research and Development Center and the Air Force Human Resources Laboratory.

At the international level, ARI researchers exchange information and conduct joint efforts with their counterparts in other countries through such organizations as The Technical Cooperation Program (TTCP) and the NATO Defense Research Group (DRG). In addition to the United States, TTCP is composed of scientists from Australia, Canada, Great Britain, and New Zealand. NATO-DRG draws its membership from the NATO nations. ARI also maintains a European Scientific Coordination Office in London. Through this SCO, ARI encourages participation of those outstanding European scientists and institutions whose work is of immediate relevance to ARI's applied research efforts.

Program Implementation

ARI's research program is conducted at four separately funded levels:

- basic research in concepts and theory;
- exploratory development research to test concepts, technology and methodology;
- advanced development research on system components; and
- engineering development to produce prototypes of specific devices or systems.

In addition, ARI performs Technical Advisory Service, which provides timely, direct assistance to the Army when problems require technical expertise rather than research or development. Army priorities influence ARI's program, which currently consists of the following categories established by Congress.

- Manpower and Personnel
- Education and Training
- Simulation and Training Devices
- Human Factors in Systems

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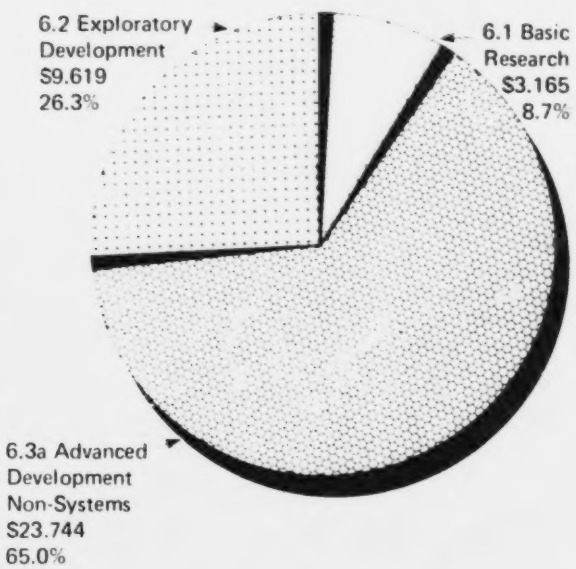
The Department of Defense coordinates personnel performance and training research through a descriptive taxonomy of research domains that was developed to guide research programs at ARI as well as at laboratories in the Navy and Air Force. These domains fall into a general sequence and encompass the following personnel-related tasks.

- Structure and Equip the Force
- Man the Force
- Train the Force
- Develop Units
- Maintain Force Readiness

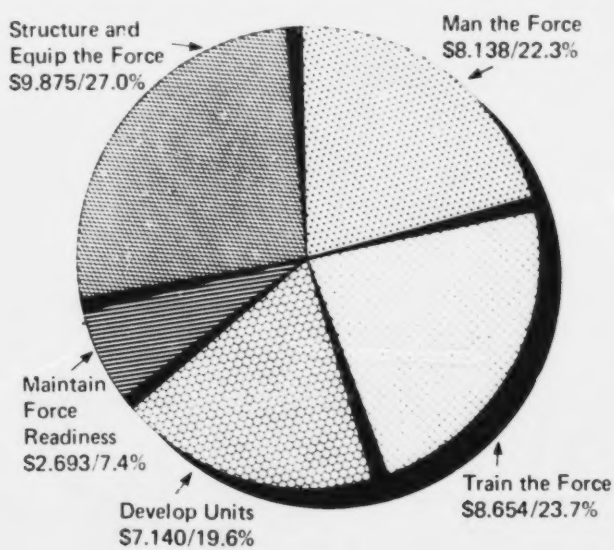
ARI's annual research program is carried out through topical thrusts within each programmatic domain. A thrust, such as *Recruiting* or *Managing Personnel Readiness* defines a specific area of investigation and includes one or more work units of scientific research at the project level. All three levels—domain, thrust, and work unit—are dynamic in that they will change somewhat from year to year, in response to both near-term and long-term objectives of the Army.

Brief descriptions of ARI's FY83 thrusts are presented on the following pages. For each thrust, the recent or ongoing research effort of at least one representative work unit is also described.

FY83 Distribution of Program Resources by Funding Category



Percentages of the FY83 ARI Budget Spent on Research in Each Domain



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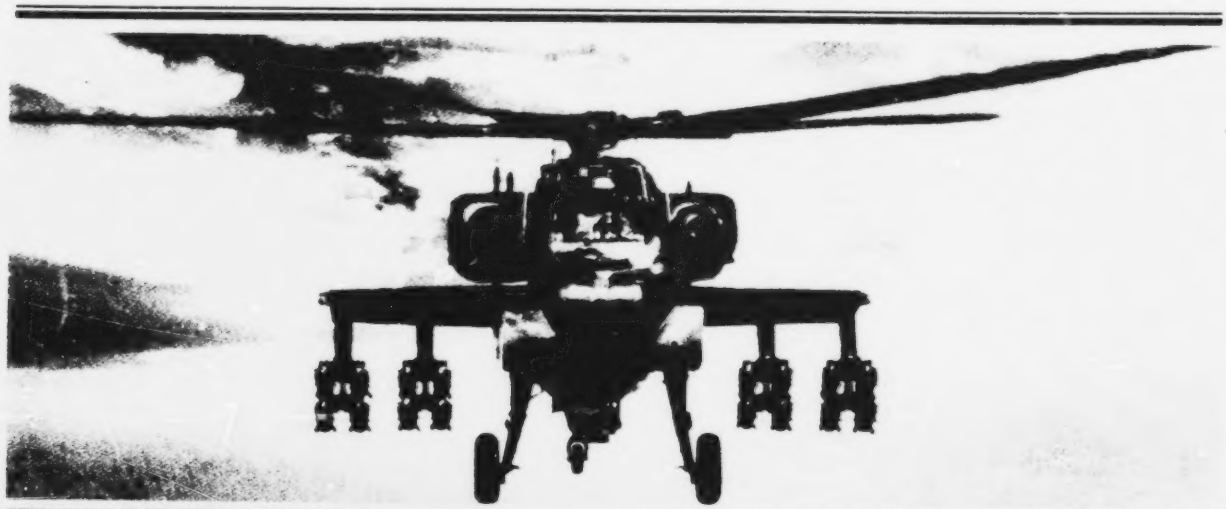
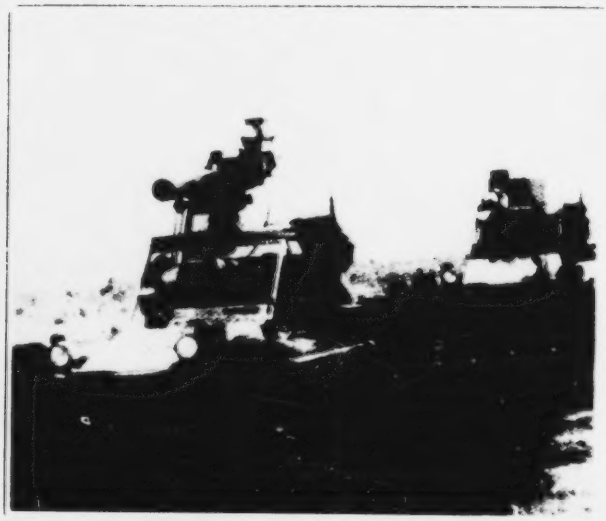
Structure and Equip the Force

The Army has over 600 items of new equipment under development, including at least 40 major systems. ARI research in this domain is helping to ensure that the Army can man these new systems, which are integral to the projected Air Land Battlefield of the Year 2000. A major focus of this research is to develop and refine technologies that will accomplish the following tasks for the Army.

- Identify capabilities and limitations of human performance so that hardware can be designed with human compatibility in mind.
- Determine ways to identify manpower, personnel and training (MPT) requirements early in systems design and ways to aggregate these requirements across systems.
- Enable the Army to design equipment that shifts monotonous, repetitive, energy-sapping tasks "from the head to the hardware," freeing the soldier for more complex decision making tasks.
- Provide more cost-effective training for persons operating and maintaining Army systems.
- Develop methods of assessing total system effectiveness that will consider human operator performance under conditions approximating those for which the system was developed.





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New System Design

It is important to define the capabilities and limitations of human performance so that new systems can be designed with human compatibility in mind. When human factors are not adequately considered by system designers, man-machine mismatches result which can seriously limit weapon system performance. Under this thrust analytical processes are being developed that will make it possible for systems designers to specify the demands placed upon humans by systems early in system design. Once these demands are known, system managers can attempt to match them with the capabilities of the available manpower pool. Should a potential mismatch appear likely, appropriate modifications in manpower policy, training procedures or hardware design can be made. In related efforts, ARI researchers are perfecting techniques for identifying those functions best performed by soldiers and those best left to machines.

Realistic Air Defense Engagement System

On today's battlefield, and even more so on the Air Land Battlefield of the Year 2000, a split-second reduction in reaction time of air defense gunners could be the key to survival. Unfortunately, today's soldiers have no previous combat experience firing ground-to-air weapon systems, and the Army has no way of knowing for sure how well they will do on the battlefield. To address these issues, ARI has initiated this research and development effort at the Fort Bliss Field Unit with the Army Air Defense School. *The Realistic Air Defense Engagement System (RADES) will provide the Army with (1) a modern, affordable, air defense training program, and (2) valid performance measures of combat readiness in this critical area.*

The best way to train air defense gunners is in a realistic short-range air defense (SHORAD) engagement environment, but the prohibitive costs of live ammunition and equipment make this next to impossible. The RADES project realistically simulated the SHORAD environment using scaled model aircraft and a portable, outdoor simulation facility. The RADES facility will be used as a research tool to find out how to improve the process of target detection, identification, tracking and engagement on the SHORAD and the man-portable air defense (MANPAD) weapon systems. Researchers will identify aspects of the gunner's job which could be improved through training or the use of performance aids. Later the facility will be converted to a training installation.

Sponsor: US Army Air Defense Center and School, Fort Bliss, Texas.

Systems Manning

In order to plan adequately for future recruiting and training, the Army needs to know the manpower, personnel and training (MPT) requirements of systems coming into the inventory. To make sure that the total supply of manpower will be enough, it is also important to be able to aggregate the total MPT requirements across all systems. ARI research in this thrust is developing methods of estimating MPT requirements early in the acquisition process.

Design of Crew and Unit Structures

This project exemplifies how ARI researchers are helping the Army find the best crew and unit structures for its weapon systems. One effort analyzed the M-109 howitzer crew, which must operate 24 hours per day on the modern battlefield. Since it is impractical to test crews for such extended periods, two modeling techniques were used: Crew Performance Model (CPM), developed by ARI, and Analysis of Military Organizational Effectiveness (AMORE). Drawing on time and motion data from existing crews, the computerized CPM methodology was used to calculate how well crews of various sizes and task assignments would fight. ARI researchers demonstrated that a ten-man howitzer crew would operate more effectively during around-the-clock combat if it were split into two identical five-man crews which were trained to alternate between weapon firing and weapon support. ARI then used the AMORE modeling technique to analyze the impact of different crew structures and other variables on the effectiveness of an entire battery and on the ability to reconstitute after battle losses. Researchers concluded that of all variables, only the restructured crew improved a unit's ability to sustain combat losses.

The practical payoff from this finding is that by concentrating on cross-training, the Army will be able to field around-the-clock fighting units which are more efficient and which can recover from losses more effectively. Research based on the CPM/AMORE methodologies is already causing a reappraisal of crew and unit structures at the Army Field Artillery School, and will eventually have applications on organizational levels throughout the Army. Similar analysis of crew and unit structures have been made for the following weapons systems: the Pershing II, the M-198 and the Division Support Weapon System (DSWS).

Sponsor: US Army Field Artillery Center and School, Fort Sill, Oklahoma.

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New System Training

Under this thrust ARI research is developing appropriate approaches for training soldiers to operate and maintain the Army's new systems.

System design currently includes reliable specification of the anticipated requirements for operator performance and maintenance tasks. As soon as the skills and knowledge required to operate a new system are known, training strategies can be developed for the system, and design specifications for training simulators can be drawn up. With the introduction of systems that include one or more computers there is now an opportunity to "embed" a training capability within systems.

Command and Control Training of Battlefield Staffs

The Command and General Staff College at Fort Leavenworth is establishing requirements for simulations targeted for use at virtually all tactical command levels from company level through corps. Simulations developed so far are primarily oriented to the battalion staff. The work has focused almost exclusively on two activities. First has been the development of automated training simulators and/or adaptation of existing ones for use as training vehicles. Second has been to introduce and gain field user acceptance of the various simulations. ARI assistance has been sought in an effort to develop training guidance for user units which, coupled with the training devices themselves, will constitute a total training system. ARI has now developed the training guidance for use of Command and Control simulations. A first edition of the Handbook on the Conduct of Training with Battle Simulations has been completed and is being updated prior to distribution in FY84.

Additional research in this area has been directed to reducing controller overhead in command group training simulations, increasing standardization of exercises, and improving efficiency of training by instructing individual or staff elements prior to group training and by training subsets of the full staff.

Research using the Army Training Battle Simulation System has revealed several command group deficiencies, including the failure to consider a large range of alternatives, persistence in unsuccessful courses of action, and not planning communication. Present and future research will address remedies for these deficiencies.

Sponsor: Command and General Staff College, Battlefield Simulation Directorate, Fort Leavenworth, Kansas.

Developing Automated Systems

Automated systems being developed under the Army's Command and Control Master Plan will process and manage large amounts of battlefield information and aid commanders in making increasingly complex combat decisions. Command, control, communications and intelligence (C^3I) systems provide the means for tactical analyses and battle management. A particular concern of the ARI research under this thrust is the soldier-system interface, both in command and control systems and in weapon systems. Here ARI research focuses primarily on applying technology to enhance soldier performance. The program addresses such human factors concerns as the design of the physical interface between the soldier and his hardware, the software required to optimize soldier/system transactions, and the design of portable job aids for the individual soldier. Collective performance in automated C^3I systems is also addressed.

Techniques for Intelligence Analysis

ARI recently completed a four-year research project, Investigation of Methodologies and Techniques for Intelligence Analysis (IMTIA). The IMTIA effort, conducted jointly with the Army Intelligence and Security Command, developed a descriptive model of generic intelligence analysis processes, concentrating on the cognitive activity of the analyst and how this activity should be supported with automation. Based on the model, decision aids pertaining to different types of intelligence were then developed. One such aid, ENCOA—Enemy Courses of Action—was recently made available. ENCOA exists in two forms: a paper-and-pencil manual accompanied by a hand-held calculator, and a computerized version. ENCOA breaks down the decision problem into tactical components, with each breakdown more specific than the one preceding.

Currently, two additional projects are underway to apply the results of IMTIA to the development of training materials. The INTACT (Integrated Tactical Analyst Training) project, aimed at tactical all-source analysis, is resulting in a training circular and lesson materials for teaching cognitive skills and analytical procedures. Another goal of INTACT is to provide recommendations for incorporating existing automated systems into the analyst training program at Ft. Huachuca.

The HASTIA (Handbook for Strategic Intelligence Analysis) project focuses on strategic, as opposed to tactical, intelligence analysis. It is resulting in the production of a handbook designed

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specifically for new analysts entering the Intelligence and Threat Analysis Center. The handbook describes processes used by strategic analysts and includes a catalog of companion procedures and tools.

Sponsors: US Army Intelligence and Security Command; US Army Intelligence Center and School; Army Intelligence and Threat Analysis Center; Assistant Chief of Staff for Intelligence

Assessment of New Systems

New systems must be tested to determine how closely they meet design criteria. One objective of these tests is to find out what the soldier must do to make the system effective. The difficulty in doing this is to select the appropriate criteria for measuring the human contribution to system effectiveness early in the system engineering process. These criteria are essential to the Army Systems Acquisition Review Council (ASARC) process. Research is needed to develop these criteria and then to develop the appropriate procedures for employing them to recommend refinements in system design which will maximize human performance. At our Fort Hood Field Unit we are evaluating human factors problems in existing systems in order to improve these systems. The illustration below summarizes our work on the M1 tank.

Army Systems Acquisition Review Council Guides

Hundreds of millions of dollars can be saved over the life cycle costs of Army weapons systems if manpower, personnel and training requirements are considered early in the Army's systems acquisition process. The Army Systems Acquisition Review Council (ASARC) reviews new weapons systems at various stages to decide whether their development should continue. With enough relevant information and the know-how to apply it, they can help avert man-machine mismatches and the costly consequences.

With completion of this ARI research, the ASARC now has a more systematic approach for collecting and using data relevant to manpower, personnel and training (MPT) issues. ARI published a guide entitled *MPT Requirements for Materiel System Acquisition*. It is intended for action officers who must prepare documentation for ASARC review on manpower, personnel and training issues such as train-up and man-machine compatibility. The guide lists key MPT issues for each review, the types of information necessary to address those issues, and where the information can be found. Today, all action officers at the Soldier Support Center and key Department of the Army staff action officers use ARI's MPT life cycle system management guide. *The guide is helping prepare for a more thorough and accurate examination of MPT issues during the ASARC process. The ultimate payoff from this and related ARI efforts is both in dollar savings and improved weapon system performance.*

Sponsor: Deputy Chief of Staff for Personnel, DA

STINGER Reverse Engineering

ARI recently completed an analysis of how human factors and manpower, personnel and training issues were addressed in the acquisition of STINGER, a one-man, portable, ground-to-air missile. Reverse engineering provides a way of retracing the steps in the acquisition and development of weapons systems. The STINGER reverse engineering project yielded valuable information about the acquisition process and how the Army can make it work better.

In the case of STINGER, many soldiers were unable to operate the weapon successfully. Once the reasons for this were clear, *ARI researchers found that revised training and some changes in the STINGER MOS were a better solution than an expensive retrofit of the weapon itself.*

The purpose of conducting reverse engineering on STINGER was to see when, and how thoroughly, human variables were addressed in the development process. *From ARI's analysis it was learned that the major keys to improved acquisition are: (1) more detailed and exhaustive specifications of human requirements and (2) more systematic linkage of these requirements to test and evaluation procedures.*

Following the STINGER reverse engineering project, the Deputy Chief of Staff for Personnel requested that ARI conduct reverse engineering on three additional systems which focus on issues relating to crew performance, high technology and maintenance. The weapons systems chosen are the Multiple Launch Rocket System (MLRS), the Black Hawk helicopter (UH-60) and the built-in test equipment on the Abrams tank (M1 BITE).

Sponsor: Deputy Chief of Staff for Personnel, DA

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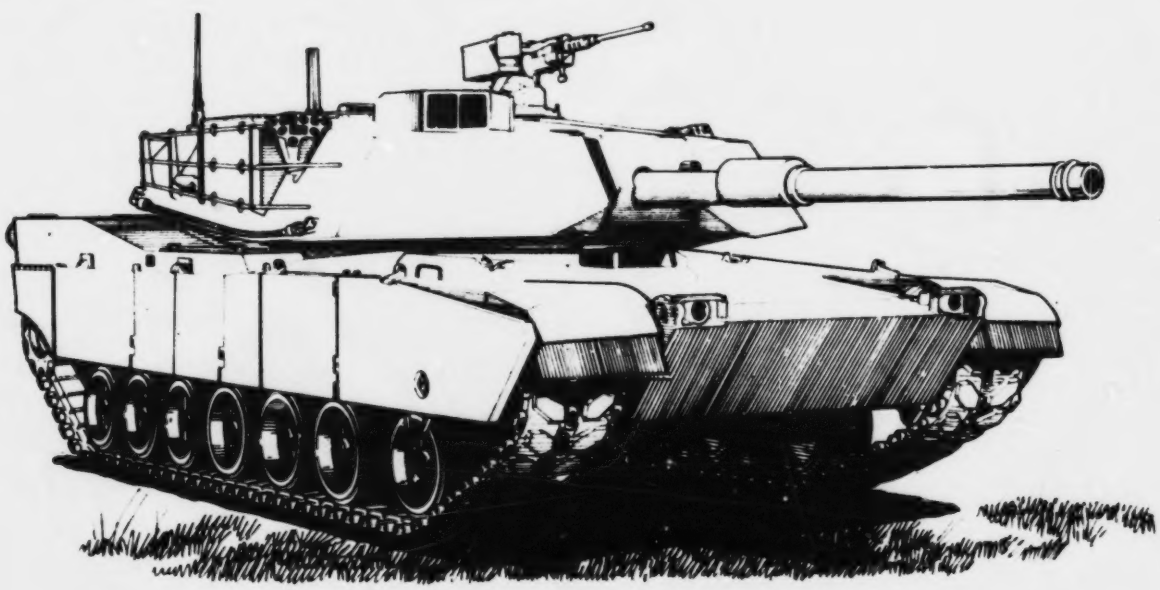
M1 Abrams Tank

Findings/Recommendations

- 94 Existing or Potential Man-machine Interface Problems Identified
- 20 of These Problems Deemed Serious Enough to Significantly Degrade the System and Reduce Combat Effectivenss
- Deficiencies in Duty Stations, Weapons Systems Control, Sighting Systems, Crew Safety
- Maintenance Problems
- Difficulty in Interfacing with NBC Protective Gear

Implementation

- ARI Research Used as Basis for Incorporating Design Changes in New Production Models of Abrams Tank
- Establishment of Design Criteria for Future Tank Systems
- Revised Training Programs to Minimize Impact of Identified Deficiencies



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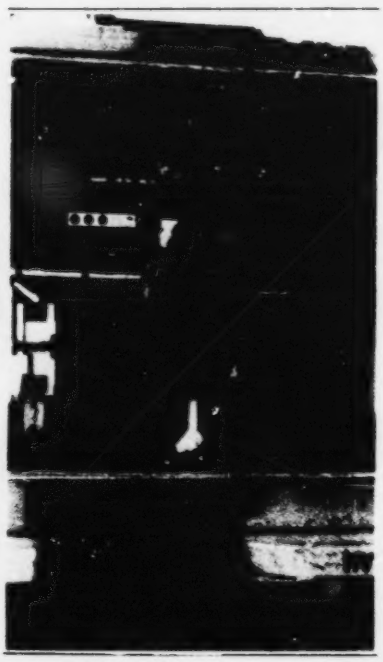
Man the Force

Manning the modern Army poses an immense challenge, particularly in a period, as today, of constrained and diminishing personnel resources, and increasing diversity and sophistication of jobs. To man today's force the U.S. Army maintains the largest personnel system in America. Each year the Army recruits, selects, classifies, trains, and assigns well over 100,000 new soldiers to the force structure. In addition, it supports, develops, deploys and manages these new soldiers as well as the hundreds of thousands of first-term and career soldiers already comprising both the active Army and the Reserve. In order to provide the thousands of leaders—both commissioned and noncommissioned—needed to manage this force, a system of recruiting, selecting, training, assigning, and developing leadership at all levels is also in operation.

Manning the force encompasses a sequence of complex tasks. Personnel requirements for manning the Army of the future have to be projected. Personnel resources for meeting those requirements have to be identified and ensured, either through retention of highly qualified soldiers already in the Army or through recruitment. Anticipated resources must be effectively allocated to anticipated requirements. Individual soldiers then must be recruited, selected, classified, and assigned to training tracks so as to optimize the fit between Army job requirements and individual soldier capabilities. Programs for retaining effective soldiers are needed in order to take maximum advantage of the enormous investments in training and experience that an effective soldier represents. In response, ARI has developed a research program to aid the decision makers in the Army's personnel system.



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Personnel Requirements and Resources

The Army is undertaking its greatest modernization program since World War II. Each of the hundreds of items of new equipment and systems will impose requirements for personnel in various numbers and of diverse skill mixes. In the past, when the Army could meet this demand through the draft, there was little need to focus much attention on future supply and demand. Today, however, it is necessary to consider both. ARI research under this thrust is helping the Army meet its manpower requirements by providing the methods, tools and data bases to project accurately for the years ahead who will be needed and who will be available. These methodologies include sophisticated task analysis, computer simulations, surveys, mathematical gaming, modeling and other techniques for analyzing resources and requirements and estimating optimal matches.

Econometric Enlistment Models

This ongoing project is providing the Army with current demographic information on the pool of prospective recruits both in the near and distant future. ARI has developed and is now refining an enlistment model which uses multivariate analysis to determine the effect on Army enlistments of such variables as unemployment, military pay, the size of the eligible population and educational benefits. The state-of-the-art methodology employed in construction of the model will make it possible to predict more accurately the number of enlistments under different economic scenarios. *The findings will have a wide impact on policy in such areas as compensation and benefits, educational incentives, and distribution of recruiting resources.*

Among the important preliminary conclusions:

- *A decrease in the present unemployment rate of one percent would reduce Army male enlistees by about nine percent.*
- *Each 10 percent drop in military pay rates relative to civilian wages causes total enlistments to fall by about 20 percent and high-quality enlistments by about 10 percent.*
- *A $25 monthly increase in veteran's educational benefits would increase yearly enlistments of high school graduates by 3,400.*

In the year ahead, the model will undergo validation and its data base will be expanded.

Sponsors: Director of Military Personnel Management, Director of Human Resources Development; Office of Deputy Chief of Staff for Personnel, DA; US Army Recruiting Command

Recruiting

Despite the recent upturn in enlistments, the all-volunteer Army cannot always be assured of meeting recruiting quotas. Army recruiters compete with universities, private industry and the other services at a time when demographic changes have reduced the traditional population pool from which recruits are drawn. The challenge for the Army is focused in three principal areas:

- increasing the number of applicants;
- improving recruiter performance through better selection, training, evaluation and motivation of recruiters; and
- making analytical trade-offs among such controllable variables as selection standards, initial assignments and enlistment incentives.

To meet these challenges the Army will require advanced state-of-the-art techniques in behavioral science, mathematical modeling and computer technology. These advances will include computer-aiding of various instructional programs, economic modeling of enlistment incentives, computer adaptive preliminary tests to predict applicant performance on enlistment tests, psychosocial profiles of successful recruiters, modeling the enlistment process and other innovations.

Survey of Army Recruits

1982 marked the best year for Army recruiting since the inception of the All Volunteer Force, both in number and quality, as measured by prior academic performance. In order to maintain these standards in an improving economy, personnel policy planners need to know more about these recruits and why they decided to enlist, as well as whether any advertising and recruiting practices are related to the upturn. To obtain this information, ARI surveyed over 12,000 recruits from the Regular Army, the Army Reserve and the Army National Guard. The last survey of this scope was conducted by the Department of Defense in 1979, a particularly disappointing year for Army recruiting. The ARI survey incorporated crucial questions from the earlier survey so that the data could be compared. Data analysis is still underway, but *the following conclusions have been reached concerning the active Army:*

- Overall the mos. important motivating factor for recruits was the *opportunity to learn a skill.*

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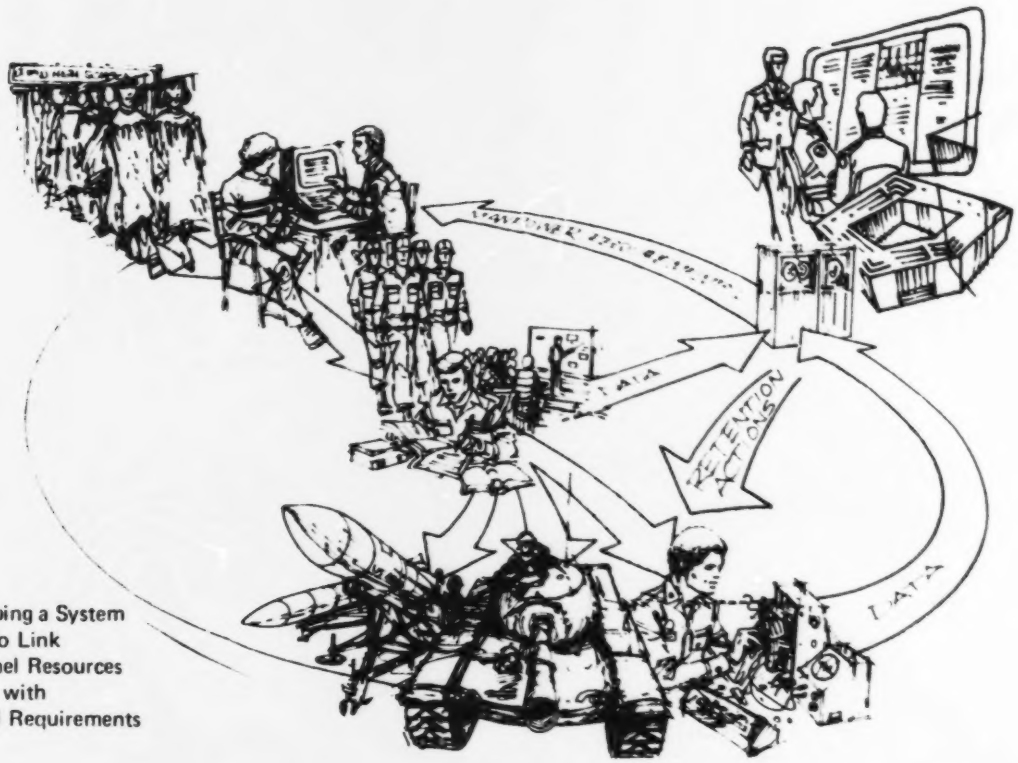

Developing a System to Link Personnel Resources with Personnel Requirements

- High AFQT scoring recruits listed as their primary motivation the *chance to earn money for college*—nearly one-third of the soldiers eligible for the Army College Fund said they would not have joined any military service without it.

- *Patriotic motivations* were listed first by one out of ten recruits—the same as in 1979.

- More than twice as many respondents in 1982 as in 1979 listed *unemployment* as their main reason for enlisting, although this was still a far less important motivating factor than the opportunity to learn a skill or a chance to get money for college.

The results of this survey will directly influence Army policy decisions in such areas as skill-training and educational assistance, where there is a demonstrated connection to recruitment success. They will also help determine the Army's future advertising and promotion strategy.

Sponsors: US Army Recruiting Command; Deputy Chief of Staff for Personnel, DA

The Application of Computer Adaptive Testing in Army Recruiting

Currently, many applicants for enlistment into the U.S. Army are given the Enlistment Screening Test (EST), a conventionally-administered paper-and-pencil aptitude test designed to predict performance on the Armed Services Vocational Aptitude Battery (ASVAB). Psychometric developments, coupled with the deployment of microcomputers to all levels of the U.S. Army Recruiting Command as part of the Joint Optical Information Network (JOIN) System, have created a unique opportunity for nationwide implementation of state-of-the-art mental measurement techniques. In 1983, the Computerized Adaptive Screening Test (CAST) was developed and field-tested. Results indicated that CAST and EST have comparable validity, while *CAST offers a number of important advantages. Among these advantages are: shorter administration time, virtually error free scoring, better discrimination among people at the ability extremes, and potentially cheaper maintenance costs.* The test is now operational in all JOIN equipped recruiting stations and is reported to be working very well.

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Use of the CAST in place of the EST will allow recruiters to more quickly and accurately identify those who are likely to be best qualified for Army enlistment.

Sponsors: US Army Recruiting Command; Deputy Chief of Staff for Personnel, DA.

Selection and Assignment

To make the best use of the Army's limited share of available manpower, initial selection and assignment of recruits as well as selective retention of NCOs is critical. Systems are required that use automated techniques to counsel, classify and commit desired positions to potential recruits and enlistees. Refined techniques for consistently and reliably assessing an individual's abilities are needed for an accurate person-to-job match in enlisted and officer specialties as well as for the unique requirements of Army aviation. Methods for using cross-service selection measures and system-specific assignment techniques must be perfected to achieve an efficient and effective assignment process. ARI research in this thrust is helping the Army address these and other related needs.

Officer Selection Battery Development

The recent RETO Study Group (Review of Education and Training for Officers), commissioned by the Army Chief of Staff, concluded that existing officer selection test procedures needed replacement. As a result, the Chief of Staff directed ARI to develop a new selection test that would pick the best applicants for Advanced ROTC and Officer Candidate School. ARI produced the Officer Selection Battery Forms 3 and 4 (OSB 3/4)—a two-hour, paper-and-pencil, multiple-choice selection test—to predict future performance as a cadet/trainee and officer. This new test battery measures specific factors related to decision making and combat performance that will help in identifying the applicants with a higher probability of performing well as an officer.

Scheduled for implementation in December, 1983, ARI's new test battery, promises considerable savings to the Army. It currently costs the Army at least $15,000 for each ROTC cadet. The Army invests an additional $20,000 on each lieutenant enrolled in the Officer Basic Course (OBC). *Administration of the new test in place of the existing battery will result in approximately 500 more persons making it through precommissioning training each year. In terms of failures avoided, this means an annual savings of at least 7 1/2 million dollars to the Army.* If the costs of ROTC scholarships and OBC failures were included, the savings would be even greater.

Sponsors: Deputy Chief of Staff for ROTC, Training and Doctrine Command

Improving the Selection, Classification and Utilization of Army Enlisted Personnel

The Army does not now have reliable measures to separate the best soldiers from the poorest. Without such measures, there is no certainty that the Army is selecting and keeping the right people. Through this project, ARI is applying state-of-the-art technology in personnel measurement to help the Army personnel system get the right soldier in the right MOS at the right time. The objectives of the research will be met by (1) developing new ways to measure and collect data on the military applicant pool; (2) developing and evaluating new predictors of soldier performance (e.g., psychomotor, perceptual, cognitive abilities and biographical information); (3) developing new methods to measure and analyze training performance; and (4) developing and refining adequate, efficient soldier performance measures and predictors of enlisted personnel and NCO success.The payoffs for the Army will be far reaching and long term. The Army will, with confidence, be able to assure that it is *getting good people in the first instance;* that those people have been *well matched to training programs and MOSs* where they have the best chance for effective performance; that *future needs for soldiers in specific MOSs will be met* by optimizing the match between the people resources and the MOS performance requirements; and, finally, that soldiers who show *high potential for leadership roles can be identified early* in their careers so that effective programs to enhance their utilization and retention can be established.

Sponsor: Deputy Chief of Staff for Personnel, DA

Retention and Reenlistment

ARI research in retention and reenlistment is helping the Army evaluate the efficiency and cost-effectiveness of its many existing retention programs. It is also finding new ways to retain soldiers possessing essential skills and experience. Because job commitment is such a positive retention factor, efforts to evaluate how training affects commitment are underway. Commitment also relates to certain

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personal attributes and environmental variables such as the economy. These relationships are being defined and analyzed so that they can be managed to affect retention positively.

Retention of highly qualified soldiers—officers and enlisted—ranks high among Army priorities. This is essential because of the increasingly limited manpower pool, the extensive investment in training, and the increasing need for experienced soldiers to operate and maintain Army equipment. Particularly costly training is in aviation; a UH-1 helicopter pilot with four years of active duty in a flight position represents an investment in excess of $200,000.

Management Techniques to Improve Retention

Consolidated under this project are several ARI efforts to develop management techniques for improving the effectiveness of the Army's retention and reenlistment programs. These techniques are being designed for use by unit commanders, reenlistment program officers and others with responsibility for retaining higher qualified military personnel.

To isolate the management variables having the greatest impact on retention and reenlistment, ARI examined such factors as: the effect of Department of the Army policies, individual command policies, soldier demographics and location at ETS. The results to date indicate a definite correlation between the adoption of certain management techniques and lower-than-average attrition. For example, congruence of command discipline philosophy from the battalion commander to the platoon leader results in lower unit attrition rates. Further study is underway to confirm and to quantify these findings; specific recommendations for management initiatives will follow.

Sponsor: Deputy Chief of Staff for Personnel, DA

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Train the Force

ARI research in this domain focuses upon improving Army training. With conventional training costs increasing steadily, improvements must be found outside the traditional approaches of more facilities, more instructors and more training devices. Higher levels of performance must come through fewer training personnel and at less cost than today. Refined training methods and applications of new instructional technologies will enable the Army to meet this challenge. ARI's research program in training the Force is designed to provide the training community with the scientific and engineering foundation upon which to develop new and improved methods for training the Army of today and the future.

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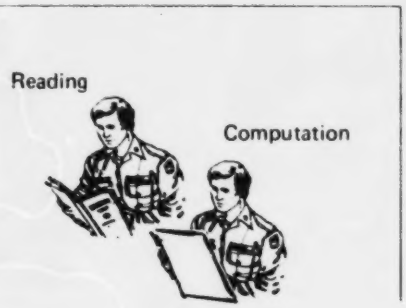
Developing Basic Skills



This research thrust gains its shape from a previous ARI program identifying the most appropriate instructional and learning strategies for soldiers of varying ability. While low-aptitude personnel may have the potential to serve effectively in a military occupational specialty (MOS), they often do not possess the basic knowledge necessary for Army life. Ongoing research is developing methods for improving the basic skills of marginal performers in order to increase their chances for successful Army careers. Special training strategies and techniques are being developed to prepare such personnel to master basic learning skills, which will enable them to learn their military duties and MOS tasks.

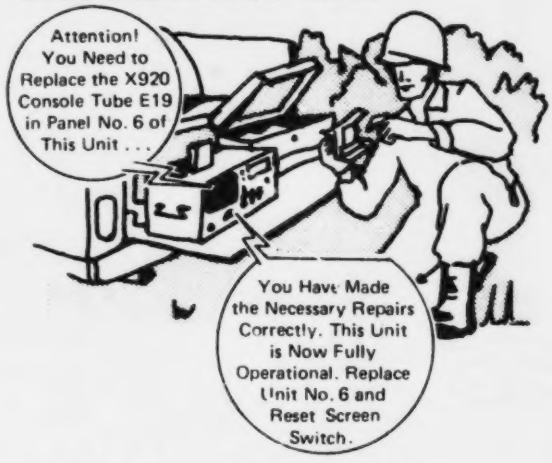
Computerized Tutor

The Computerized Tutor has been developed by ARI as an inexpensive supplement to classroom instruction which assists soldiers in learning the technical vocabulary of the various military occupational specialties. The hand-held Tutor incorporates synthesized speech, a 32-character display screen, a keyboard and a game-like approach to guide soldiers through a tested instructional program. It is a user-friendly, portable device weighing less than four pounds and requires no previous computer experience. *The Tutor is now teaching the vocabulary of the cannon crewman MOS to soldiers enrolled in Basic Skills Education Program classes at Ft. Polk.* Preliminary data show high user acceptance and training effectiveness.

In addition to vocabulary instruction, the Tutor can be adapted for other applications such as the teaching of job-related mathematics and foreign languages.

Sponsor: Office of the Adjutant General—Education Directorate

Developing Individual Skills


Attention! You Need to Replace the X920 Console Tube E19 in Panel No. 6 of This Unit . . .
You Have Made the Necessary Repairs Correctly. This Unit is Now Fully Operational. Replace Unit No. 6 and Reset Screen Switch.

Research conducted under this thrust seeks to strengthen the development of basic combat skills, help the soldier to acquire individual job skills and to advance and maintain his/her technical skills. ARI research efforts consider such variables as: amount of training required to achieve full proficiency; frequency of training needed to maintain desired performance levels; the optimal training medium as a function of type of learning required (i.e., the learning of a simple procedural skill *vis a vis* a complex decision making skill); the optimum mix of simulators, training devices and other training media into a comprehensive training program; and performance measures for assessing training performance and the adequacy of the training provided.

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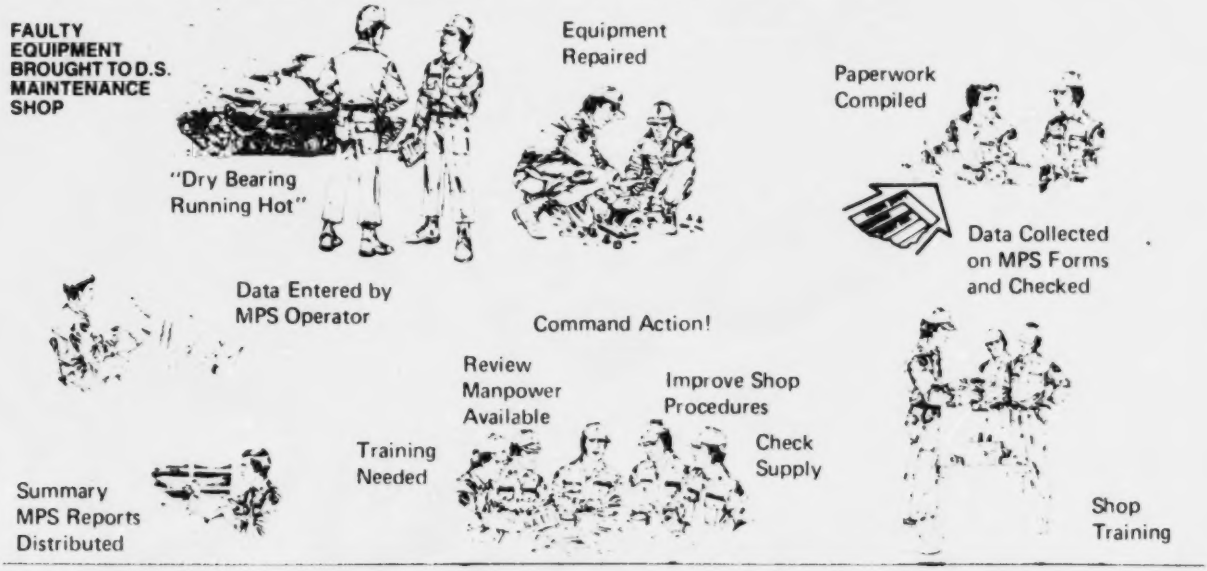
Maintenance Performance System

ARI designed a computer-based Maintenance Performance System (MPS) which provides information on the productivity of maintenance units, the quality of maintenance, and the proficiency of mechanics. The system produces an inventory of a unit's available skill. *Two types of information are available at all times: what any specific individual needs in terms of training or experience, and what the unit needs based upon the current skills of the mechanics.* MPS enables commanders of maintenance units to track individual skill development for purposes of training and job assignment and at the same time to target unit training to actual needs. In addition, commanders can determine the overall effectiveness of maintenance operations and pinpoint problem areas in the repair process. It has been tested following implementation at two FORSCOM posts, and the results are being integrated into the Standard Army Maintenance System.

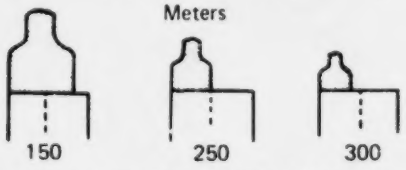
Sponsor: U.S Army Training Board, Training and Doctrine Command



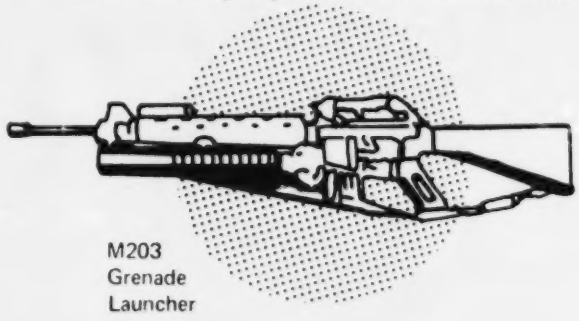
Grenade Launcher Range Estimation Device

This project demonstrates how ARI researchers develop performance aids to increase the effectiveness of Army weapon systems. In training exercises, both novices and experienced grenadiers make significant errors in estimating the distance to targets up to 350 meters away—the maximum effective range of the M-203 grenade launcher. These errors increase sharply with distance, greatly reducing the probability of a first round hit. To remedy this problem at an affordable cost, ARI developed a simple device which allows the matching of a man-sized image to hole sizes gauged for various distances. The device would replace the seldom used M-203 leaf sight and requires no weapon modification.

A prototype of the device has undergone successful field experiments at Fort Benning, and *the preliminary results indicate that it reduces errors in estimation by 50 percent at all distances between*



- Target Larger Than ½ Blade Width – Closer than 250 Meters
- Target Equals ½ Blade Width – Target at 250 Meters
- Target Smaller than ½ Blade Width – Farther Than 250 Meters



M203 Grenade Launcher

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50 and 350 meters. If further tests confirm its effectiveness, the device will go into full-scale production soon, and a revised M-203 training program could result.

Sponsor: US Army Infantry Center and School, Fort Benning, Georgia

Designing Technology-Based Instructional Systems

Computers and electronic technology offer great potential for helping the Army provide efficient and cost-effective training, in units as well as in institutional settings. The critical research problem is determining how recent and emerging technological advances can be applied most effectively to the Army's training requirements. ARI scientists working within this thrust are addressing the design of technology-based instructional systems that may be used for the presentation of instruction in a wide variety of subject matter areas. Particular emphasis is upon cost-effective applications of microelectronics technology to the design of personal learning systems. Efforts are also underway to develop advanced technological methods for training MOS skills and to adapt interactive automation technology for Army training.

Computer-Based Functional Basic Skills Education Program II

There is presently a lack of continuity between on-duty Army skills education programs and off-duty high school completion programs. To rectify this, ARI is developing a computer-based, job-related curriculum for Basic Skills Education Program II. The curriculum will be based on an analysis of the prerequisite skills for 94 high-density MOSs. During FY84, 300 hours of instruction will be developed. An additional 120 hours will be developed the following year. At least half of the total 420-hour curriculum will be computer-based. Two TRADOC and two FORSCOM sites will be used as test sites. When implemented it will provide soldiers with an alternative method for obtaining a high school diploma, and with the minimum level of educational competency necessary to serve at MOS skill levels 1 and 2 (through grade E-5).

Sponsor: Education Directorate, The Adjutant General Office

Developing Simulators and Training Devices

The growing cost of using operational equipment and live ammunition, the lack of suitable training sites, and the increasing complexity of modern weapon systems are placing new emphasis on simulations and training devices to reduce the increasing cost of training. New electronic technology may find its greatest application in the design of more cost-effective simulators and training devices. Regardless of the technology employed, however, effective training must provide opportunities to learn and to practice the skills under conditions similar to those encountered on the job. But how similar should those conditions be? A major issue which researchers are considering under this thrust is the tradeoff between physical and psychological fidelity. Efforts are also underway to design simulation techniques for maintenance training and to develop a method for estimating and or measuring the training effectiveness of simulators and training devices at various stages of development.

Army Maintenance Training and Evaluation Simulation System

ARI's technical expertise has been enlisted in a program to develop a state-of-the-art simulation system for maintenance training and evaluation. The program is being conducted by the Army's Project Manager for Training Devices (PM TRADE). As part of its contribution, ARI is helping to make sure that any new training devices developed will bring about effective training. Researchers are assessing the effectiveness of alternative Army Maintenance Training and Evaluation Simulation System (AMTESS) prototypes. They are also assessing the training effectiveness of specific AMTESS features such as two-dimensional and three-dimensional information displays. From this information they will establish guidelines for the purchase of new simulation systems. Data collection has been completed on automotive training at the Aberdeen Proving Ground and on electronic training at Ft. Bliss, and a preliminary analysis of the data has been conducted. ARI's methodology for reporting on the projected effectiveness of AMTESS at various stages of development will prove invaluable in guiding future procurements of maintenance training devices.

Sponsor: US Army Project Manager for Training Devices, Materiel Development and Readiness Command; US Army Ordnance Center and School, Aberdeen Proving Grounds, Maryland

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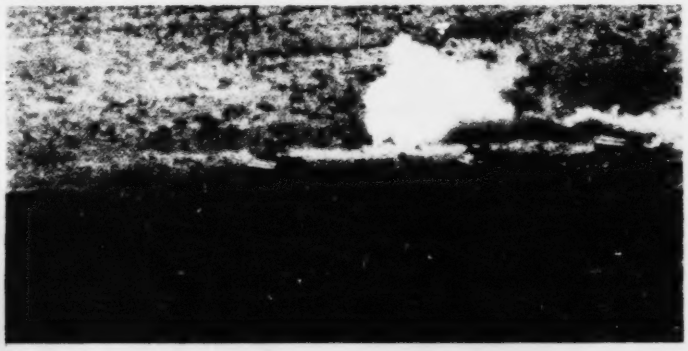
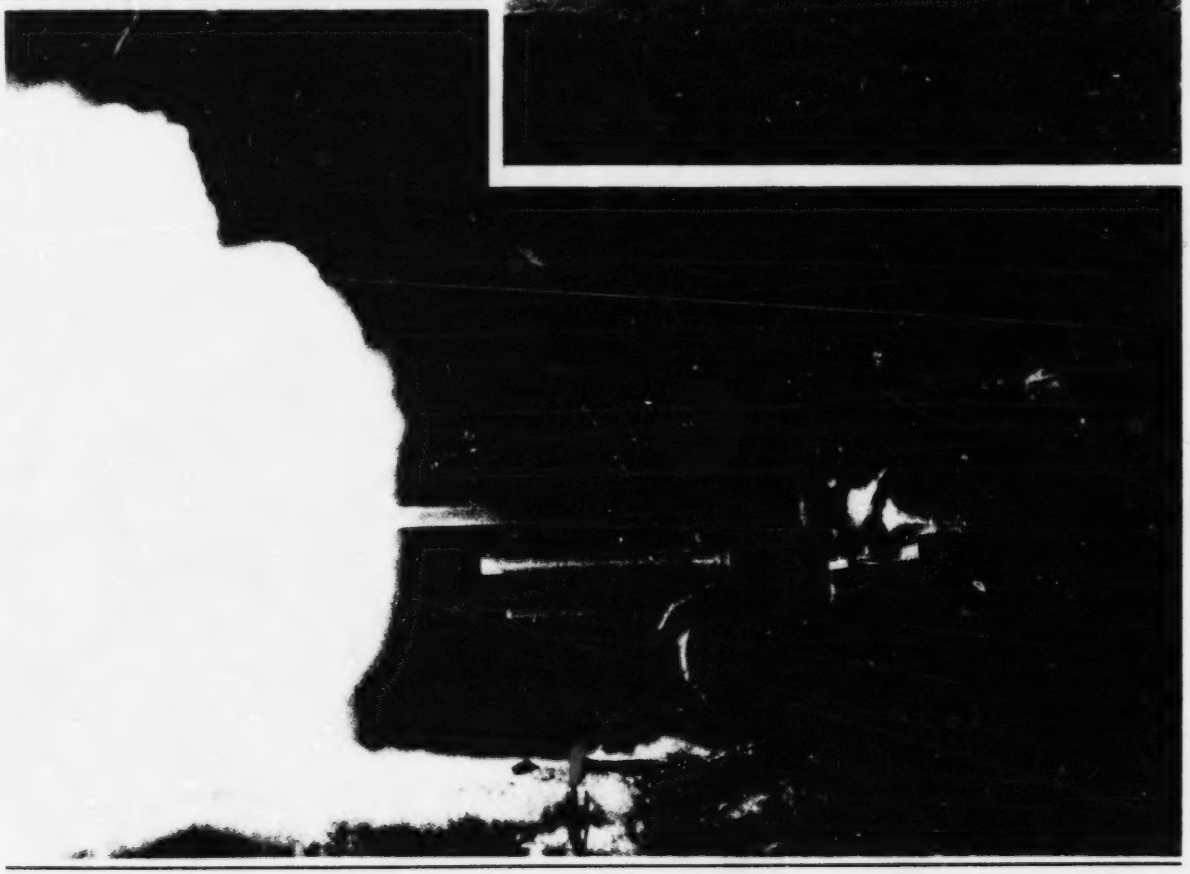
Develop Units

Soldiers arrive in units fresh from the training base, usually with journeyman level skills limited to their MOS. In their unit of first assignment they must learn to perform their duties alongside others so that the unit will meet its assigned mission.

Soldiers are ready for combat only when they have been fully integrated into teams, crews and units and perform their tasks in concert with others. Victory in combat cannot be attained without successful unit performance.





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Developing Collective Skills

Once soldiers achieve a prerequisite level of proficiency in individual skills, they are ready for unit training. Research in this new thrust focuses on developing crew and team skills as well as unit operational skills. Collective training is conducted under conditions which vary considerably from those encountered by soldiers during their initial training experience. The highly structured supportive training environment of initial entry training is replaced by a less structured environment that requires both adaptability and initiative. Alternative strategies for conducting this training are being designed and developed and their effectiveness evaluated. Here, as in related training thrusts, special emphasis is placed on the application of technological innovation to create simulated, tactically realistic, and interactive training environments.

Army Development and Employment Agency Training Systems

The Commander, 9 ID was charged with developing revolutionary approaches in tactics and equipment for the purpose of establishing a High Technology division. The new division was designed to have the tactical mobility, firepower and survivability of a heavy division with the airlift and sustainability requirements of a light division. The Army Development and Employment Agency (ADEA) was formed to manage the transition of the 9 ID to a High Technology Light Division. ARI has contributed to ADEA's mission by assisting in developing specialized training programs for the uniquely configured High Technology Light Brigade. (HTLB): Unit performance guides have been written for the following prototype battalions of the HTLB: Light Motorized, Light Attack and Assault Gun. Drill trainer's guides have been prepared for Assault Gun Crews and Platoons, Light Attack Squads and Platoons, and Light Motorized Squads and Platoons. *These newly developed ARI products are now serving as the basis for the rapid train-up of HTLB battalions at Fort Lewis.*

Sponsors: ADEA, 9th Infantry Division; Army Training Board, TRADOC

The High Technology Light Division

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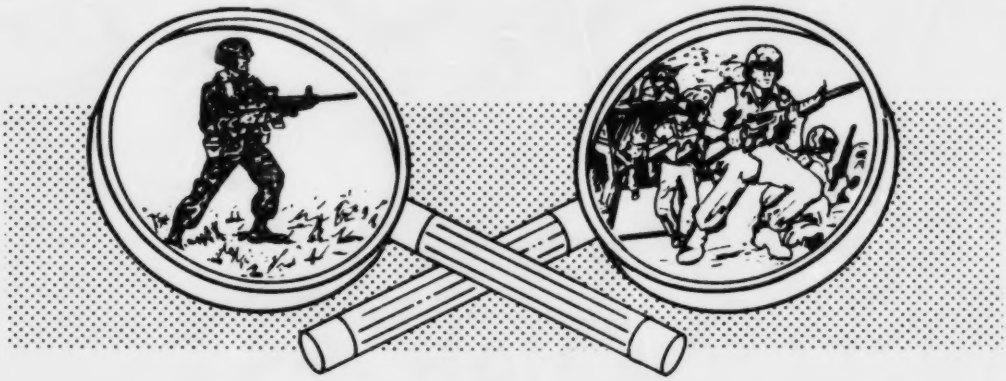
Assessing Individual and Unit Proficiency

Measurement of proficiency requires accurate assessment of individual and collective performance. For simple procedural tasks, this is relatively straightforward, but for more complex cognitive tasks as well as for collective performance, the challenge of accurate measurement is much greater. ARI efforts are directed toward the development of simple and cost-effective measures of individual job performance and establishing the best procedures for assessing team and unit proficiency.



National Training Center Training and Evaluation System

The National Training Center (NTC) at Fort Irwin, California tests the Battalion Task Force under the most rigorous and realistic conditions ever devised for training. Through the NTC Training and Evaluation System, ARI is helping the Army capitalize on the unequalled training experience at NTC.

The initial phase of the project is in progress. A computer system is being installed at ARI's Presidio of Monterey Field Unit which is fully compatible with NTC, Fort Irwin facilities. ARI will perform the same training review functions at the ARI Unit Performance R&D Center as are performed at NTC.

Using this system researchers are analyzing current NTC procedures for evaluating training performance. They are also seeking better ways to summarize and present the voluminous data generated during training so that the Army can make better use of NTC's data bank by providing feedback to units, schools and decision makers.

NTC research to date has resulted in the acquisition of Basic NTC Simulators and the creation of a conceptual framework for the use of NTC data.

Sponsor: TRADOC Systems Manager-National Training Center (TSM-NTC)

The Tank and Mechanized Infantry Battalion Task Force

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Assessing Training System Effectiveness

Evaluation of training effectiveness concerns measuring individual and collective proficiency after training, as well as analyzing the training itself. The Army has a critical need to determine how effectively its training programs and systems are satisfying training requirements. It is essential to know why training achieves or misses its objectives. Based on this information, Army training developers can modify curriculums and procedures to increase the efficiency and effectiveness of training. Within this research thrust researchers are determining the cost effectiveness of training programs and systems evaluating the tradeoffs between simulation and other methods of training. Related efforts are underway to assess training technology transfer.

Collective Training Information System

The Army Training and Evaluation Program (ARTEP) has become the commander's standardized measurement of how well a unit is trained. It serves as the primary tool and criterion guide in training his unit, from weapons crews to the battalion level. The Collective Training Information System (CTIS) is an interactive management information system that will improve the effectiveness and efficiency of ARTEP.

CTIS will assist collective training and evaluation by providing training managers and developers with a comprehensive data bank, based in part on data from the Automated Battalion Training Management Information System. The data bank will include a library of all collective tasks, evaluation mechanics, unit performance data on all ARTEP tasks, and trends analyses of training at the unit level. When fully operational, *CTIS will result in more effective utilization of ARTEP and in improved diagnosis of ARTEP performance by unit commanders to determine combat readiness.* In addition, it will provide systematic feedback to ARTEP developers at Army schools, enabling more cost-effective and timely refinement of training doctrine, requirements and support.

Sponsor: US Army Training Board, TRADOC

Managing Training

Standardized procedures exist for managing training at the institutional level, but training management in the unit presents a special challenge. Unit training managers must cope with limited personnel resources for training, a host of training materials and training devices, and little guidance on how to conduct effective training. Senior NCOs and junior officers are especially important in the successful conduct of unit training. They serve in the dual role of trainers and trainees; depending on the level of training being given at any one time, they may be either. The senior NCO must be prepared to provide instruction in skills related to military occupational specialty (MOS), yet he must also lead his troops during tactical training exercises. As a result, research in this thrust is directed at providing unit training managers with the guidance that will permit them to carry out their training management function effectively in the same environment where they must also learn critical aspects of their own tactical duties.

Methods for Implementing and Evaluating Training Developments

Training methods that prove successful in field tests do not always work so well in operational units. To change this, ARI scientists have devised a set of model procedures for implementing new training developments. They are described in a recent ARI Technical Report, *Model for Guiding Implementation, Evaluation, and Integration Support of New Training Products in the Army.* This report explains how to plan effectively for the development and implementation of any new training program, including the monitoring of progress and the sustainment of the training development until it is integrated into routine Army training.

Sponsor: Director, Tactical Engagement Simulation, TRADOC

Leader Development

Effective performance as a leader requires a variety of skills, which are developed through the sequence of training, practice and evaluation. Research efforts in this thrust are programmed to identify the critical functions of leaders on the battlefield of the Air Land Battle 2000, and to lay a foundation for appropriate leadership doctrine and practice.

Pilot Experiment in Cognitive Skill Training

This project seeks to determine whether or not it is possible through training to enhance the cognitive skills that leaders need to function effectively in complex and uncertain situations. In cases where

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research shows that the skills can be enhanced through training, researchers will develop and test methods to ensure that the skill enhancement will result in improved leader and unit performance in field situations.

A pilot training program to enhance cognitive skills in leaders was tested on third-year military science cadets at 12 senior ROTC units. Their performance scores and ratings received the following summer at Advanced Camp were then compared with cadets not receiving the special training. Preliminary data show considerable promise, and a phase 2 pilot program, significantly improving upon the first, will be carried out at additional ROTC units in Fall, 1984.

Sponsor: Deputy Chief of Staff for ROTC

Leadership Requirements for the Future Battlefield

Much attention has focused upon the operational technology of Air/Land Battle 2000, but attention has only recently been given to a related topic of significance: the leadership requirements on the future battlefield. In order to stimulate research in this important area, ARI sponsored a working conference in May, 1983, at Texas Tech University.

A wide array of experts was convened to examine all aspects of this topic. Among them were psychologists, sociologists, management scientists from academia and the government, and military leaders responsible for the Army's leader development program. The conference accomplished several objectives. Participants developed strategies for organizational design and for forecasting changes in leadership requirements under high-stress and high-technology battlefield conditions. The concept of leadership was expanded beyond the traditional idea of face-to-face interpersonal influence into a broader notion of systems leadership. The broadened concept encompasses the management of information and interaction with information systems. Papers presented at the conference were compiled in a volume, "Leadership on the Future Battlefield," which is being used by ARI research managers to plan future research in this thrust.

Sponsor: Deputy Chief of Staff For Personnel, DA

Differential Assignment Battery

At present, the process by which officers are assigned to initial and second specialties does not adequately take into account aptitude, experience, interest and other aspects of personal and psychological makeup. In the past this has contributed to job dissatisfaction and unacceptably high turnover in key leadership positions. The objective of this research, initiated as a result of a Human Research Need from the Office of the Deputy Chief of Staff for Personnel and the Military Personnel Center, is to determine if more formalized specialty assignment procedures can be developed. Despite the obvious need, an officer assignment battery does not currently exist anywhere in the military.

ARI researchers now have two officer assignment test batteries under development, one for first specialty designation and one for second specialty (which officers are required to choose after seven years of service). The researchers are reducing the 39 Officer Personnel Management System specialties to 10 or so relatively homogeneous job "families." To predict job performance and satisfaction, these job families will then be related to such variables as aptitudes, interests, hobbies, training and education, experience, competence, and vocational and career goals. The successful completion of this promising ARI research would enable an improved match between the officer and the assignment. From this the Army can expect improved performance by the officer, greater officer satisfaction and, ultimately, higher retention of high quality officers.

Sponsors: Deputy Chief of Staff for Personnel, DA; Military Personnel Center (MILPERCEN)

Organizational Cohesion

As the Army moves to new manning systems such as unit replacement and unit rotation, the ways that soldier cohesion and commitment are developed must be better understood. Through a scientific understanding of cohesion and commitment, the Army can identify, design, and develop the necessary personnel policies, procedures, and methodologies to assure that the new manning systems will work to full advantage. To bring this about, ARI research under this thrust is analyzing the effect of personal attributes and Army training on commitment to the service and the job. Based on these results, related efforts are developing methods to enhance team work, cohesion and mission commitment. These efforts began only recently and will be reported in next year's annual report.

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Maintain Force Readiness

For a fighting force to be combat ready, units must be up to strength, their equipment operational, and all soldiers skilled in carrying out their responsibilities. Personnel, equipment and doctrine must be combined and effectively utilized. The research program within this domain addresses the personnel-related problems which may prevent the Army from achieving its desired state of readiness.

Maintaining force readiness is approached from three perspectives. One program thrust focuses on maintaining the readiness of personnel in field units, one on maintaining training readiness, and one on the procedures to be followed by Army personnel if they are to employ modern weapon systems effectively on the field of battle. In some ways, this research represents the culmination of efforts conducted within the other four domains. It involves integrating the results of the earlier individual research projects into comprehensive personnel policies, training programs, or weapon system employment techniques. It may also involve the demonstration of innovations that may help to improve unit functioning and performance.

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Managing Personnel Readiness

Combat units deployed overseas must be ready to fight at a moment's notice, and those stationed in the United States must be ready for rapid deployment to remote outposts across the globe. Combat support units and combat service support units must also be ready at all times to perform their functions. If they are to achieve an optimal state of combat readiness, commanders in the field need the tools to develop and to maintain the performance capabilities of the individuals and the units they command. They must be able to manage military personnel during the continuous operations envisioned on the Air/Land Battlefield of the Year 2000. Research in this new thrust is helping the Army attain this capability.

Management of Change and Unit Effectiveness

The US Army is currently involved in the implementation of major changes designed to enhance its operational effectiveness. Among these changes are the following:

- Force Modernization—which involves the fielding of hundreds of new high performance weapons and weapons systems;
- New Manning System—which involves the recruitment, training and subsequent rotation of units as opposed to individuals designed to enhance cohesion among soldiers and overall training proficiency;
- Division 86 Restructuring—designed to enhance the capabilities of units to field new equipment; and
- Air Land Battle—which reflects the doctrine that the Army of the 1980s and 1990s would use on the battlefield of the future.

While each of these changes has been designed to improve the effectiveness and readiness of units, the extent to which their interactions and interfaces are known is at present uncertain.

The focus of this research project is to devise a set of "change-management strategies" for use at multiple levels within and throughout the Department of the Army. When applied, these strategies would yield greater levels of net efficiency at the battalion level. To accomplish these objectives the research has begun by conducting a front end analysis of the actions that have been taken by the proponents of each of the major changes previously listed. A case study has also been designed to assess the extent to which these changes are being managed by battalions deployed in US Army Europe (USAREUR). These efforts are designed to produce a prototype automated management system for use at differential levels throughout the Army that will enable enhanced planning, programming and budgeting, and subsequent fielding of major army initiatives through the year 2000. In addition to providing guidelines and recommendations on how to manage change, this research is also designed to provide input for the evolving systems integration doctrine presently underway within the Army.

Sponsors: Deputy Chief of Staff for Operations and Plans, USAREUR; Combined Arms Center, Fort Leavenworth, Kansas

Maintaining Proficiency

Once individuals and units have achieved desired levels of proficiency, this level must be maintained. Units must be ready to carry out their assigned missions in a combat ready fashion; individuals must be prepared to support their unit through their own proficient behavior. Research in this thrust contributes to the development and evaluation of comprehensive programs to support individual and collective training in the field, especially through refresher-training and cross-training. Current emphasis is on the combat arms. Also under this thrust are projects developing, demonstrating and evaluating technology-based training and job performance aids that show promise of maintaining proficiency in personnel throughout the services.

Personal Electronic Aid for Maintenance

During the next decade, the increasing density of new equipment and the decreasing supply of people will require new, more effective information handling methods to improve the effectiveness of units. The trends in current computer development toward lower cost, increased power, and miniaturization hold promise for compact automation of information now conveyed only by masses of paper.

The Personal Electronic Aid for Maintenance (PEAM) is a joint Army-Navy research effort for developing, testing and evaluating a hardware, software and authoring system for use by maintenance personnel. Its purpose is to improve the productivity of the organizational level maintenance technician by enhancing the quality, management and delivery of technical information. PEAM will consist of a "front end" authoring function, and a compact, portable delivery system for the electronic presentation of maintenance information at the field site. A prototype of PEAM is scheduled for field testing in FY84. It incorporates flat-panel displays, voice technology, new mass-storage devices and micro-computer technology. If successful, PEAM will minimize supervisors' training requirements, assist in circumventing

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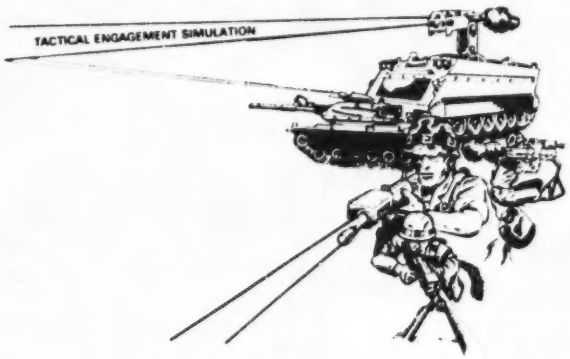
soldier reading problems, and improve the quality of maintenance by providing task-specific, on-the-spot guidance, for the individual technician.

The Army can expect immense benefits from PEAM. Research has shown that at the organizational level *only 23 percent of maintenance tasks are performed correctly, 33 percent of the technicians performing final checks do them correctly, and 40 percent of the parts removed are not defective.* It is anticipated that *the use of a properly designed electronic aid can result in at least 20 percent improvement in these areas as well as a reduction in repair times by as much as 50 percent.* Substantial cost-benefits are also anticipated from the device due to more efficient methods for producing, updating and distributing technical information. Prototype delivery by the prime contractor, Texas Instruments, is scheduled for the fall of 1984. Testing will begin shortly thereafter with mechanics on the Abrams Tank (M1) System. Available now are design mockups and several micro-computer-based concept demonstration programs.

Sponsor: Office of the Under Secretary of Defense Research and Engineering

Employing Weapon Systems

Soldiers are trained to operate weapon systems for maximum fire power and to keep them battle ready. The dynamics of the battlefield require that these weapon systems be employed singly and collectively, in concert with other weapon systems in combined arms operations. Techniques for employing a single type of weapon require a full appreciation of its capabilities, and of the best employment methods for it to achieve the design capability. Also critical is an understanding of how weapon systems should be combined in tactical operations to obtain maximum benefits from the special capabilities of each type of system. The principal research efforts in this thrust are (1) developing the means for enhancing weapons employment effectiveness, (2) conducting combined arms operations and (3) improving target acquisition.



Individual Ready Reserve Aviator Training Program

ARI has developed a revised Program of Instruction (POI) for the Immediate Ready Reserve (IRR). The revised POI has made it possible for IRR aviators to be assigned as replacements to a FORSCOM unit within the seven days required by mobilization and will enable them to regain the level of proficiency prescribed by the Air Crew Training Manual within 19 days after call up.

As part of the new POI, pretraining materials were developed for aviators to study before arriving at an active unit for training. Diagnostic pretests were developed to identify individual deficiencies so that aviators could receive training tailored to their varying levels of skill. *As a result of using the new POI and tests, there was more effective use of training time and resources. For example, the number of times required to perform each flight maneuver was reduced significantly.*

Three regional training centers, under the auspices of FORSCOM, will implement the new program. The Fort Rucker center is currently in operation, and two additional centers are scheduled to begin in FY84 or FY85.

This revised POI assures the Army of a predictable level of readiness and will lead to measurable savings in reduced training costs.

Sponsors: Director of Training, Deputy Chief of Staff for Operations and Plans, DA; Reserve Component Personnel Administration Center; Aviation Directorate, Deputy Chief of Staff for Operations, Forces Command

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ARI Staff Recognition

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Awards

Presidential Meritorious Senior Executive Rank

Joseph Zeidner

This award was presented to Dr. Zeidner for sustained accomplishments, outstanding leadership, and ingenuity demonstrated during his service to the federal government and the nation.

Department of Defense Distinguished Civilian Award

Joseph Zeidner

Each year the Secretary of Defense awards the Department of Defense Distinguished Civilian Service Award to six DOD civilian employees whose careers reflect exceptional devotion to duty and extremely significant contributions of broad scope to the efficiency, economy, or other improvement in the operations of DOD. Dr. Zeidner, who retired in 1983 from government service as ARI's Technical Director, received this award in recognition of scientific achievements contributing to improvements in the operations of the Department of the Army and of the Department of Defense. This award consists of a gold medal and citation certificate signed by the Secretary of Defense.

Meritorious Civilian Service Award

James A. Thomas

This award is the second highest Department of the Army honorary award and consists of the medal, rosette, and citation certificate. It was awarded to Dr. Thomas for his demonstration of unusual initiative and skill, particularly in documenting and reordering Army equal opportunity training policies and procedures. According to the award citation, his efforts as a program manager and a research scientist represent an outstanding contribution to the Army's success in sustaining its equal opportunity objectives and thereby contributed significantly to the improvement of racial harmony in the Army.

Army Research and Development Achievement Award (Joint Award)

Newell K. Eaton—M.A. Fischl

Dr. Eaton and Dr. Fischl were cited for their contributions to the state-of-the-art of personnel evaluation techniques, and for their outstanding achievements in research, which resulted in the successful development of the Recruiter Development Center. Their efforts significantly improved the quality of the Army recruiting force.

Special Act or Service Award

Norman D. Smith

Dr. Smith received a $5,000 cash award for his leadership and ingenuity as project leader for the ARI team that developed the Army's Target Acquisition and Analysis Training System (TAATS). Under this project a series of interrelated combat vehicle identification programs have been developed and adopted for use on an Army-wide basis. The US Marine Corps and selected USAF schools have also recently adopted the program.

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Publications and Presentations

ARI Publications

ARI publishes Technical Reports, Research Products, Research Reports, and Research Notes. Interested persons with access to the Defense Technical Information Center (DTIC) may obtain reading copies from there. The general public may obtain copies from the National Technical Information Service.

The documents are announced in the DTIC's *Technical Abstract Bulletin* and in the *Government Reports Announcements and Indexes* put out by the National Technical Information Service. The Technical Report follows the completion of research and development projects sponsored by the Army. The purpose of the Technical Report is to communicate research findings and other information generated by these projects. Technical Reports are directed primarily to the research and development community.

The Research Report is similar in content to the Technical Report, but it is more operational and aimed at an audience of military managers and policy makers.

Research Notes are reports of research submitted to DTIC but not produced for hard copy distribution by ARI. These reports enable ARI to preserve information of long-term value which, due to limited scope or audience, may not justify the cost of production as a Technical Report.

The Research Product is a user-oriented document directed toward those applying research and development findings in the field.

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